Lawrence Livermore National Laboratory

May 27, 1982
SM 82-149
Docket 50-206

Mr. P. Y. Chen
Systematic Evaluation Program Branch
Division of Licensing
Office of Nuclear Reactor Reg.
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear P. Y.:

I have enclosed an agenda and a questionnaire for the upcoming meeting on the SONGS I seismic reevaluation. The questionnaire includes items from the program plan review that remain open.

Sincerely,

Thomas A. Nelson

Thomas A. Nelson
Structural Mechanics Group
Nuclear Test Engineering Division

TAN/mg
01771

Enclosure

cc: Ting Lo

GROUP II SEP SEISMIC REVIEW

The presentation by the licensee or his A/E should be limited to structures. The discussion should cover the general topics listed below for the structures important to safety.

A. Identify the critical systems and the structure (or structures) housing them. Include the NRC minimum list of systems together with any others judged critical.

B. Provide a list of structures currently included in the evaluation and a general description of these structures and their foundations. Prioritize the structures in accordance with importance for safe shut down.

C. Provide a brief summary of the original seismic design basis of the structures identified in 'B' together with any subsequent upgrades of remedial work.

D. Provide a resolution of open items related to structures identified in the program plan review.

E. Discuss the status of the current SEP evaluation. For each structure provide the following:

   i. Seismic input used in the analysis including a description of the ground response spectra and/or time histories used.

   ii. Describe the analytical models and methods used including soil-structure interaction effects, location of seismic inputs to the model, embedment effects, mass and stiffness modeling, damping assumptions and interaction with adjacent structures.

   iii. Describe the analysis results including frequencies and mode shapes of the important modes, as well as the structure response accelerations, displacements, shears, moments and torsional response. Discuss the generation of in-structure response spectra including effects of structure torsional response, consideration of floor slab vertical amplification, and peak broadening techniques.

   iv. Masonary block walls need not be included. However, the interaction effect of these walls to the structures, if any, should be discussed.

   v. Discuss loads and load combinations considered including multi-axial seismic input. Discuss the acceptance criteria used and the evaluation of the structure seismic capacity including stress levels at key locations. Identify areas of concern and proposed upgrades.

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QUESTIONNAIRE ON SEISMIC REEVALUATION OF SONGS 1 STRUCTURES, FIELD ERECTED TANKS AND BURIED PIPING

I. Open Items on Seismic Reevaluation Program Plan

Your letter from K. P. Baskin to D. M. Crutchfield of NRC, dated April 12, 1982, provided responses to the comments forwarded to you via our January 19, 1982 letter. Several items for the program plan remain open, as delineated below. The item numbers are the same as those referred in our January 19, 1982 letter.

Item 1 "No explicit mention of the soil property variation range is made. The program for BOP structures refers to a Reference 3."

Your April 12, 1982 letter indicated that you will respond by June 4, 1982.

Item 2 "The program plan for BOP structures refers to a Reference 8, Design Guide C-2.44. It appears to be a Bechtel inhouse document which should be made available for review."

Your response is not detailed enough for us to complete our review. We request a more detailed and precise comparison between C-2.44 and BC-TOP-4A for those sections actually referred to in your seismic reevaluation analyses of the structures.

Item 7 "At least one more time history analysis of the NSSS using a different set of time histories is required because nonlinear response of the system is very sensitive to characteristics of the input time histories while many of the components, according to the nonlinear analysis, have a safety margin of only 1.1."

For those components having a safety margin of 1.1, as shown in Table 3.9.1.5.2 of Ref. 1, their actual calculated safety margins were probably 1.10 or even less. Such small values of the safety margin may be very sensitive to the nonlinear modelling, input motion characteristics, and analysis methodology. While we are still reviewing the verification document for the Westinghouse WECAN code, we believe at least one more time history analysis using a new set of time histories to be necessary. The information provided in your April 11, 1981 letter from Baskin to Ziemann (Ref. 2) did not satisfactorily resolve the sensitivity concern mentioned above.

Item 10 "Verification of Westinghouse analysis codes was not provided."

WCAP-8281, "Verification of the WECAN Computer Program Nonlinear

Elastic Dynamic Analysis Capability," May, 1974 is still under review by the NRC staff and consultants. We will discuss this subject further during the meeting.

II. Reactor Building and Containment Sphere

Seismic reevaluation of the reactor building, containment sphere and NSSS was reported in Ref. 1. A set of open items was identified from a previous review of Ref. 1 by the NRC staff and consultants, which was forwarded to you during a November 14, 1979 meeting (Ref. 3). Your response to these items was provided in Ref. 2.

A more recent review of Refs. 1, 2 and 3 by the NRC staff and consultants identified additional questions on Ref. 1 and the Ref. 3 open items that were not adequately resolved by your Ref. 2 responses. The comments are listed as follows.

(1) Soil property variability was not adequately accounted for because only one set of soil properties, corresponding to a shear modulus of 4100 ksf, was considered. The concern is primarily on the effect of soil property variation on the in-structure response spectra. For example, Ref. 1 showed that the soil rocking mode frequency varied from 3.7 to 5.0 Hz when the soil shear modulus was varied from 4100 to 8000 ksf. Such frequency uncertainty exceeded the ±15% broadening of the floor spectral peaks that was used in the reevaluation program. Provide your plan to account for the effect of the soil variability.

(2) Regarding the through-soil structure-to-structure interaction, Ref. 2 quantified the effect of the enclosure building on the reactor building while no information is available about such effect on the steel containment and in-structure response spectra. Provide this information so that we can complete our assessment of the reevaluation of the containment and its supported components and systems.

(3) Provide details on the trial and error method that was used in determining the soil springs in the reactor building model. In addition, Ref. 2 did not satisfactorily address the Open Item No. 6 in Ref. 3 which questioned the two-order-magnitude difference between the horizontal and vertical soil springs of the reactor building model.

(4) The modal damping values of the reactor building model as shown in Table 3.7.2-3 of Ref. 1 differed from those presented in Ref. 3. Provide your reconciliation of this discrepancy.

(5) For the containment sphere finite element model, there may not be enough number of elements of the steel shell in the sand-filled cavity at the shell-base juncture to accurately predict

the local bending stress distribution inthe shell. Provide your justification to circumvent this concern.

(6) The feedwater pipe load at the pipe penetration on the containment was included in the stress evaluation of the containment shell. Privide information on the magnitude of this pipe load and the method and source for its derivation.

(7) The axisymmetric finite element model for the containment shell does not account for the local stresses at and around the major penetrations. Provide clarification on how the containment local stresses at the penetrations were determined.

(8) Provide evaluation of the shell buckling potential near the shell-base juncture of the containment where high compressive stress in the hoop direction may develop due to thermal loads.

(9) Clarify the magnitue of the internal pressure that was used in computing the compressive membrane stresses shown in Table 3.8.2-4, Ref. 1, in the containment shell. The text in Ref. 1 appears to suggest that the 49.4 psig accident pressure was used throughout the shell stress computation, which would be unconservative as far as the compressive membrane stress evaluation is concerned.

III. Balance-of-Plant Structures

Comments on evaluation of the masonry walls are not included here, except where structure and masonry wall interaction occurs. The questions are divided into two categories, i.e., general and individual structures. The general questions are those which apply to more than one of the Balance-of-Plant (BOP) structures.

General (Refs. 4,5,6,7,8,9,10)

(1) Where soil-structure interaction was included in the analysis, identify the soil properties that were used in determining the soil springs for each of such BOP structures. In addition, provide information on how the uncertainly in soil properties was accounted for, such as by considering a range of soil property variation as recommended in the SSRT Guidelines for Soil-Structure Interaction Review (Ref. 11).

(2) For the soil-structure interaction analysis of the control and administration building, turbine building and fuel storage building, how were the soil damping ratios computed where soil springs were used? Provide this information for each of these three buildings.

(3) Three dimensional structural models were used in the seismic reevaluation of the control and administration building, turbine building and fuel storage building. How were the connections

between the elements representing the masonry walls and the elements representing the rest of the structure modelled?

(4) Variation of the modulus of elasticity, Em, of the masonry walls with frequency was considered in the control and administration building seismic model. Was similar consideration given to the masonry walls represented in the ventilation building, turbine building and fuel storage building models?

(5) For out-of-plane nonlinear analyses of the individual masonry walls, such as for the turbine building, the effect of the building structure was typically represented by an equivalent single-degree-of-freedom (SDOF) system. What is the criteria for determining the mass and spring stiffness of the SDOF system?

Individual Structures

(A) Circulating Water System Intake Structure (Ref. 4)

A1. In the analysis of the exterior walls and base slabs, were their inertial loads accounted for in addition to the applicable earth pressure and hydrostatic and hydrodynamic pressures?

A2. The intake and discharge culverts below Elev. (-)7'9"" were analyzed as a box frame using the method of moment distribution.

(a) What and how were the dynamic earth pressures applied to the two side walls and the base slabs?
(b) Was culverts' inertial load included in the analysis?
(c) Were shear loads and vertical seismic loads from the north and south pumpwells included in the analysis, in addition to the application of concentrated moments that were equal to the allowable moments at the bases of these two walls?

A3. Partial restraints, where used, were specified at the beam ends or plate edges representing walls or slabs, by applying allowable moments of the adjoining walls or slabs. This may not be conservative as far as the maximum positive moment is concerned because such allowable moments may exceed the negative moments that can possibly be developed due to the actual loads on the beam or plate under consideration.

A4. For the three pumpwell walls that exceeded the BOPSSR criteria, it was stated that failure of these walls would not occur under the DBE because of the "conservative assumptions" in computing the dynamic soil pressures. It is our understanding, however, that only 2/3 of the peak ground accelerations was used in the dynamic soil pressure calculations and that the effects of the three earthquake components were combined using the 1, 0.4, 0.4 rule, which is similar to the SRSS combination intended to recognize the unlikelihood of the simultaneous occurence of the maximum effects from the three earthquake components. Therefore, clarify the conservative assumptions cited in Ref. 4 that would preclude failure of the three walls under DBE until the walls are modified.

(B) Reactor Auxiliary Building (Ref. 4)

B1. How were the seismic loads (shear, moments, vertical inertial loads, etc.) from the above-grade portion of the building included in the analysis of the embedded portion of the reinforced concrete structure?

B2. How was the inertial load of the metal deck roof diaphragm computed? In addition to considering the masonry wall connection reaction forces, was the metal deck inertial load included in the evaluation of the metal decking?

(C) Ventilation Equipment Building (Ref. 4)

C1. The worst condition soil bearing pressure occurred when the full effect of east-west seismic component was combined with 40% of the effect of the north-south seismic component. It is our understanding, however, that a north-south seismic analysis was not performed. Provide your clarification.

(D) Control and Administration Building (Ref. 5)

D1. What is the procedure for computing the cracked section moment of inertia, Icr, for the reinforced concrete walls and slabs that were represented by plate elements in the finite element model?

D2. A fixed base assumption was used in the analysis of the finite element model for static loads while a flexible base (soil-structure interaction) was considered in the seismic analysis. Provide your justification on this inconsistency.

(E) Turbine Building (Ref. 6)

E1. How were the connections between the gantry crane legs and crane rails modelled in the three dimensional structura analysis model?

E2. How were the column base connections modelled?

E3. Provide design details for the concrete slab to steel framing connections (steel inserts and shear connectors). Also, provide details on the shear connectors that are to be added where such modifications are necessary.

E4. The double-pin connections between the masonry wall tops and deck slabs are not intended to transfer in-plane shear loads from the masonry walls. Are they sufficient to accomodate the differential movement between the wall tops and deck slabs in the in-plane direction?

(F) Fuel Storage Building (Ref. 7)

F1. In considering soil-structure interaction, how were the soil springs and damping ratios distributed at the switchgear room wall footing?

F2. How was the foundation slab at Elev. 14'0" modelled in the three dimensional seismic analysis model?

F3. What is the definition of the "effective length" of wall in the derivation of the out-of-plane masonry wall properties?

F4. Horizontal and vertical analyses were separately performed, and the response time histories were then combined. Justify the validity of this approach because both analyses were non-linear time history analyses.

F5. Was the linear, elastic model developed for the frequency extraction only, and not for any response analysis?

F6. Your conclusions stated that "The 'as-built' structure was subjected to earthquake motions of the specified DBE level of 0.67g Housner for San Onofre Unit 1 and complied with the structural integrity acceptance criteria under this load." It is our understanding that only the El Centro records were used in a structural integrity evaluation of the building while Fig. D.2 indicate that the El Centro records do not envelop the 0.67g Housner spectra. Provide your justification of the accuracy of aforementioned conclusion statement. Our particular concers are with the wall FB-7 and roof connections to walls FB-6 and FB-7.

F7. Provide information on the reevaluation of the foundation, which is not currently included in Ref. 7.

IV. Field Erected Tanks and Buried Piping (Ref. 12)

(1) Justify the exclusion of soil-structure interaction consideration from the reevaluation of the field erected tanks.

(2) Justify the rigid tank assumption used in the reevaluation of the field erected tanks, such as in computing the hydrodynamic fluid pressures inside the tanks.

(3) Provide information on evaluating the buckling potential of the tank shell near the tank base.

(4) Provide the methodology for reevaluation of the buried piping.

References

1. "San Onofre Nuclear Generating Station Unit 1, NRC Docket 50-206, Seismic Reevaluation and Modification," Southern California Edison and San Diego Gas & Electric Company, April 29, 1977.

2. Letter from K. P. Baskin of SCE to D. L. Ziemann of NRC, April 11, 1980.

3. Memo from H. A. Levin to D. M. Crutchfield, Systematic Evaluation Program Branch, DOR, USNRC, January 3, 1980.

4. Letter from K. P. Baskin of SCE to D. M. Crutchfield of NRC, December 8, 1981.

5. Enclosure 1 to Letter from R. W. Krieger of SCE to D. M. Crutchfield of NRC, February 9, 1982.

6. SONGS 1 BOP Structures Seismic Reevaluation Program, Turbine Building and Turbine Generator Pedestal, Enclosure 1 to letter from K. P. Baskin of SCE to D. M. Crutchfield of NRC, April 30, 1982.

7. SONGS 1 Seismic Evaluation of Reinforced Concrete Masonry Walls, Vol. 4: Fuel Storage Building, prepared by Computech Engineering Services, April, 1982.

8. SONGS 1 Seismic Evaluation of Reinforced Concrete Masonry Walls, Vol. 1: Criteria, Computech Engineering Services, January, 1982.

9. SONGS 1 Seismic Evaluation of Reinforced Concrete Masonry Walls, Vol. 2: Analysis Methodology, Computech Engineering Services, January, 1982.

10. SONGS 1 Seismic Evaluation of Reinforced Concrete Masonry Walls, Vol. 3: Masonry Wall Evaluation, Computech Engineering Services, January, 1982

11. "SSRT Guidelines for SEP Soil-Structure Interaction Review," prepared by Senior Seismic Review Team (SSRT) for NRC, December, 1980.

12. San Onofre Nuclear Generating Station Unit 1,"Balance of Plant Mechanical Equipment and Piping Seismic Reevaluation Program" Southern California Edison, April, 1982

SAN ONOFRE 1 AUDIT PLAN FOR SEP SEISMIC
QUALIFICATION OF PIPING, MECHANICAL, AND ELECTRICAL EQUIPMENT

I. Background

In October, 1977, the office of Nuclear Reactor Regulation (NRR) initiated Phase I of the Systematic Evaluation Program (SEP) to determine the margin of safety relative to current standards for eleven selected operating nuclear power plants and to define the nature and extent of retrofitting required to bring these plants to acceptable levels of safety if they are not already at these levels. Phase I of SEP involved Group I plants, where Phase II involves Group II plants, consisting of San Onofre 1, La Crosse, Big Rock Point, Yankee Rowe, and Haddam Neck. The review for seismic requalification of SEP Group II plants will be performed by two teams. One team consisting of NRC staff personnel and NRC consultants from Lawrence Livermore National Laboratory (LLNL) will evaluate the Group II plants' structures. A second team consisting of NRC staff personnel and NRC consultants from EG&G Idaho, Inc., will evaluate the Group II plants' piping, mechanical, and electrical equipment important to safety. This audit plan provides a description of how the SEP seismic requalification of San Onofre 1 piping, mechanical, and electrical equipment important to safety will be reviewed.

II. Scope

The scope of review for the SEP seismic re-evaluation program will include the systems and components (including emergency power supply and distribution, instrumentation, and actuation systems) with the following functions:

1. The reactor coolant pressure boundary as well as the core and vessel internals. This should also include those portions of the steam and feedwater system extending from and including the secondary side of the steam generator up to and including the outermost containment isolation valve and connected piping for

all safety related systems up to and including the first valve that is either normally closed or is capable of automatic closure during all modes of normal reactor operation.

2. Systems or portions of systems that are required for safe shutdown as identified in the SEP safe shutdown review (SEP Topic VII-3). The system boundary includes those portions of the system required to perform the safety function and connected piping up to and including the first valve that is either normally closed or capable of automatic closure when the safety function is required.

3. Systems or portions of systems that are required to mitigate design basis events, i.e., accidents and transients (SEP Topics XV-1 to XV-24). The functions to be provided include emergency core cooling, post-accident containment heat removal, post-accident containment atmosphere cleanup, as well as support systems, such as cooling water, needed for proper functioning of these systems.

4. Systems and structures required for fuel storage (SEP Topic IX-1). Integrity of the spent fuel pool structure including the racks is needed. Failure of the liner plate due to the safe shutdown earthquake must not result in significant radiological releases, or in loss of ability to keep the fuel covered. Failure of cooling water systems or other systems connected to the pool should not permit draining of the fuel pool. Means to supply makeup water to the pool as needed must be provided.

For the San Onofre 1 plant, the following systems, and components should be addressed:

1. Reactor Coolant System (RCS)

2. Portions of Main Steam System

3. Portions of Main Feedwater System

4. Portions of systems directly connected to the RCS up to and including isolation valves

5. Control Rod Drives

6. Auxiliary Feedwater System

7. Residual Heat Removal System (including ECCS recirculation mode)

8. Portions of Chemical and Volume Control System

9. Portions of Service Water System

10. High Pressure Safety Injection System

11. Low Pressure Safety Injection System

12. Containment Cooler System

13. Spent Fuel Pool and Makeup

As discussed previously, a "system" also includes the power supply, instrumentation and actuation systems.

III. General Criteria and References

The criteria contained in the following documents will be the bases used to evaluate the SEP seismic re-evaluation of San Onofre 1 Plant piping, mechanical, and electrical equipment important to the plant's ability to safely withstand the effects of a postulated safe shutdown earthquake event.

1. NUREG/CR-0098, "Development of Criteria for Seismic Review of Selected Nuclear Power Plants," N. M. Newmark and W. J. Hall, May 1978.

2. Standard Review Plan, Sections 3.2, 3.7, 3.8, 3.9, 3.10.

3. Regulatory Guides, 1.29, 1.48, 1.60, 1.61, 1.89, 1.92, 1.100, 1.124, 1.130.

4. ANSI/IEEE Standard 344-1975.

5. ASME Boiler and Pressure Vessel Code Section III, 1980 Edition or subsequent.

6. AISC, "Manual of Steel Construction," Eighth Edition.

The intent of Phase II of SEP is to demonstrate that the structural integrity of the systems and components being re-evaluated will not be impaired when subjected to a postulated Safe Shutdown Earthquake (SSE) in combination with other normal design loadings. As a minimum, component primary stresses must be evaluated using current criteria provided in the above standards for Level D (faulted) service limits.

IV. Review Procedures

A. General

The review team (NRC and NRC consultants) will perform the review effort parallel with the licensee's seismic re-evaluation efforts. A minimum of three working level meetings among the review team, licensee, and licensee's consultants are anticipated. This method of review has been selected in order to expedite the review. The working level meetings will permit an exchange of information which will minimize formal written communication, thus expediting the program. One of the meetings will be conducted at the plant so the review team can perform a field inspection of the equipment being re-evaluated.

The review process will be accomplished in three steps. The first step will consist of the review team reviewing the details of the seismic re-evaluation program plan submitted by the licensee. A substantial portion of this review has been performed. A summary of this review is contained in Appendix A. Contained at the end of this summary are concerns which require response by the licensee. Any concerns the review team has with the program plan will be discussed and preferably resolved at the first working meeting.

The next step of the review will consist of review of analyses performed by the licensee or licensee's consultants. This review will be performed by one or more of the following methods: (a) The review team will perform a review of seismic re-evaluation analyses at the working meetings. (b) The review team will perform review of seismic re-evaluation analyses at their offices. These analyses will either be given to the review team at the working meetings or transmitted by mail to the review team upon completion. (c) The review team will perform independent analyses for some components and systems. Information necessary to perform these analyses will be supplied by the licensee at the working meetings or transmitted later. The depth of review of analyses will vary depending on the complexity of the item being evaluated. The analysis review guidelines are contained in Appendix B.

The third and final step of the review process will consist of the review team preparing and submitting a technical evaluation report (TER) which identifies the results of the seismic re-evaluation review.

B. Audit Meeting Agenda

As previously mentioned, the SEP will require working level meetings among the review team members, licensee, and licensee consultants to be held either at the plant or at licensee's engineering offices. For the meetings at the engineering offices, the following agenda is anticipated:

1. Detailed presentation of seismic re-evaluation program plan by licensee or licensee's consultants.[a]

2. Discussion and resolution of concerns which the review team has with the program plan.[a]

3. Presentation of licensee's progress towards completion of seismic re-evaluation program by licensee.

4. Presentation of anticipated schedule for completing program by licensee.

5. Summary presentation of seismic re-evaluation analyses results (include identification of systems and components which require retrofitting) by licensee.

6. Detailed review of completed seismic re-evaluation analyses for selected systems and equipment (include detailed review of required retrofits).

7. Exit briefing identifying acceptable areas of review and areas of concern requiring additional information to resolve by review team.

For the meeting at the plant, the following agenda is anticipated:

1. Presentation of licensee's progress towards completion of seismic re-evaluation program by licensee.

2. Presentation of anticipated schedule for completing program by licensee.

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a. Required at initial meeting only.

3. Summary presentation of seismic re-evaluation analyses results (include identification of systems and components which require retrofitting) by licensee.

4. Field inspection of selected equipment being re-evaluated by review team and licensee.

5. Detailed review of newly completed seismic re-evaluation analyses, by review team (include detailed review of required retrofits).

6. Exit briefing identifying acceptable areas of review and areas of concern requiring additional information to resolve, by review team.

V. Review Team Members

The SEP review team for San Onofre 1 nuclear power plant will consist of the following NRC and EG&G Idaho, Inc., personnel.

NRC

P. Y. Chen

EG&G Idaho, Inc.

Tom L. Bridges
Sheryl L. Busch
Tommie R. Thompson

VI. Review Schedule

The anticipated schedule for completing Phase II of SEP for San Onofre 1 nuclear power plant is as follows:

1.	First working meeting	Week of 05-24-82
2.	Plant visit	Not Scheduled
3.	Final working meeting	Not Scheduled
4.	Complete TER	12-31-82

APPENDIX A. REVIEW OF LICENSEE SEP PROGRAM PLAN

Each item in this checklist is given two reviews. The first one is an "acceptance" review to check if that particular item has been addressed. The second is an "adequacy" review to judge the acceptability of the item for reevaluation purposes. Numbers in parentheses refer to comments listed at the end of this checklist.

I. Analysis Audit Format (Piping)	Addressed?	Adequate?
1. What computer codes were used in the analyses?	Yes	Yes
a. How were the above computer codes verified?	No	--
2. Is the proper input forcing function being utilized?	Yes	No (1)
a. If response spectra method is used:		
(1) Is correct spectra and damping utilized?	Yes	No (1)
(2) Have sufficient modes been used to adequately describe system response?	No	--
(3) Do system frequencies straddle any peaks?	No (2)	--

		Addressed?	Adequate?
b.	If time history method is used:		
	(1) Is proper damping utilized?	N/A	--
c.	If static equivalent method is used:		
	(1) Is justification provided for performing a static equivalent analysis?	N/A	--
	(2) How was required level of input determined?	N/A	--
3.	Has the piping system been properly modeled?		
	a. Have valves been properly modeled including any eccentricity?	Yes	No (3)
	b. Has adequate mass point spacing been utilized?	No	--
	c. Are adjacent element length ratios reasonable?	No	--
	d. Have all significant branch piping systems been included?	Yes	Yes
	e. Have all supports been specified with correct imposed loads (if any), direction and stiffness?	No	--
	f. Have supports with significant nonlinear characteristics been properly handled?	No	--

		Addressed?	Adequate?
g.	Have correct pipe sizes, geometry, thicknesses, and uniform weights been specified?	No	--
h.	Have correct design and operating pressure and temperature data been specified?	Yes	No (4)
i.	If chart methods were used, were they used correctly?	No	--
4.	Has the piping system been evaluated against proper criteria?	Yes	No
a.	Have proper stress intensification factors been utilized?	No	--
b.	Have proper load combinations been analyzed?	Yes	No (5)
c.	Have proper allowable stress limits been selected in order to assure the required operation of the piping?	Yes	No (6)
d.	Were standard or nonstandard components used?	No	--
e.	What criteria were used in evaluating adequacy of supports?	Yes	Yes

II. Analysis Audit Format (Mechanical Equipment)

1. Is the equipment rigid or flexible?

a.	How were the natural frequencies determined?	Yes	Yes

	Addressed?	Adequate?
b. If flexible, is its response single-directional or multi-directional?	No	(8)
c. If flexible, is its response at one predominant frequency or at several frequencies?	No	(8)
2. What type of analysis was performed?		
a. Static g level		
(1) How was required level of input determined?	Yes	No (7)
b. If response spectra metnod is used:		
(1) Is correct spectra and damping utilized?	Yes	Yes
(2) Is sufficient system response achieved?	No	
(3) Do system frequencies straddle any peaks?	No	
(4) How were directional components of input applied (combined)?	No	
c. If time history method is used:	N/A	
(1) Is proper damping utilized?		
(2) How were directional components of input applied (combined)?		

	Addressed?	Adequate?
d. If testing was used for requalification:		
(1) What type of test was performed?	N/A	
(2) What justification is provided for the type of test used?	N/A	
(3) How were system natural frequencies determined?	N/A	
(4) How was the required response spectra (RRS) determined?	N/A	
(5) How does the test response spectra (TRS) compare to the RRS?	N/A	
(6) What g level was used in the test?	N/A	
(7) Were support and boundary conditions, including anchor bolts, properly simulated in the test?	N/A	
(8) How was functional operability verified during the test?	N/A	
(9) What criteria were used in evaluating the adequacy of the test results?	N/A	
3. What computer codes were used in the analyses?	Yes	Yes
a. How were the above computer codes verified?	N/A	

	Addressed?	Adequate?
4. Has the system been properly modeled?		
a. Has adequate mass point spacing and distribution been used?	No	(8)
b. Have all supports and boundary conditions, including anchor bolts, been properly modeled?	No	(8)
c. Have significant nonlinear effects been properly handled?	No	(8)
5. Has the system been evaluated against proper criteria?		
a. Have the proper load combinations been analyzed?	Yes	Yes
b. Have proper stress intensities been evaluated?	No	(8)
c. Have proper allowable stress limits been selected for all load carrying elements (anchor bolts, equipment supports, equipment housing and internal elements important to maintaining structural integrity)?	Yes	No (9) (10)
d. How were computer output responses combined (directional and modal)?	Yes	No (11)

III. Analysis Audit Format (Electrical Equipment)

1. Is the equipment rigid or flexible?		
a. How were the natural frequencies determined?	No	(8)

	Addressed?	Adequate?
b. If flexible, is its response single-directional or multi-directional?	No	(8)
c. If flexible, is its response at one predominant frequency or at several frequencies?	Yes	Yes
2. What type of analysis was performed?		
a. Static g level		
(1) How was required level of input determined?	Yes	Yes
b. If response spectra method is used:		
(1) Is correct spectra and damping utilized?	Yes	Yes
(2) Is sufficient system response achieved?	No	(8)
(3) Do system frequencies straddle any peaks?	No	(8)
(4) How were directional components of input applied (combined)?	No	
c. If time history method is used:	N/A	
(1) Is proper damping utilized?		
(2) How were directional components of input applied (combined)?		

	Addressed?	Adequate?
d. If testing was used for requalification:		N/A
(1) What type of test was performed?	N/A	
(2) What justification is provided for the type of test used?	N/A	
(3) How were system natural frequencies determined?	N/A	
(4) How was the required response spectra (RRS) determined?	N/A	
(5) How does the test response spectra (TRS) compare to the RRS?	N/A	
(6) What g level was used in the test?	N/A	
(7) Were support and boundary conditions, including anchor bolts, properly simulated in the test?	N/A	
(8) How was functional operability verified during the test?	N/A	
(9) What criteria were used in evaluating the adequacy of the test results?	N/A	
3. What computer codes were used in the analyses?	No	

	Addressed?	Adequate?
a. How were the above computer codes verified?		
4. Has the system been properly modeled?	No	(8)
a. Has adequate mass point spacing and distribution been used?	No	(8)
b. Have all supports and boundary conditions, including anchor bolts, been properly modeled?	No	(8)
c. Have significant nonlinear effects been properly handled?	No	(8)
5. Has the system been evaluated against proper criteria?		
a. Have the proper load combinations been analyzed?	Yes	Yes
b. Have proper stress intensities been evaluated?	No	(8)
c. Have proper allowable stress limits been selected for all load carrying elements (anchor bolts, equipment supports, equipment housing and internal elements important to maintaining structural integrity)?	Yes	No (9, 12, 13)
d. How were computer output responses combined (directional and modal)?	Yes	No (11)

COMMENTS FROM APPENDIX A

1. The proper forcing function depends on the individual piping systems. The proper input should be considered for each piping analysis. What damping values were used for these response spectra?

2. The analyst should check if frequencies straddle response spectra peaks. Modeling techniques that result in significant loss of response due to peak straddling should be avoided.

3. Clarify procedure used in determining valve thickness. Were any upper limits placed on the valve thicknesses?

4. Operating pressure should be clarified as to whether it is the pressure in piping during normal operation of plant or coincident pressure during SSE. Also, S_h should be taken at design temperature, not operating temperature.

5. Have all expected load combinations been considered? What methods were used in combining the loads?

6. For Class 1 or equivalent piping, a calculated stress no greater than 1.8 S_h will provide adequate margin for structural integrity. For Class 2 piping or equivalent a calculated stress no greater than 2.4 S_h will provide adequate margin for structural integrity.

7. Where natural frequencies at equipment is not determined, using the peak acceleration value from the floor response spectra is not acceptable. This value must be multiplied by 1.5 to account for multiple modal participation.

8. These items are specific for each analysis and will be evaluated later during detailed review of the analyses.

9. AISC allowable stress (S) may not include 1/3 increase permitted by AISC Paragraph 1.5.6. Buckling loads may not exceed 2/3 critical buckling.

10. Concrete expansion anchors allowable load criteria was not provided.

11. Combination of modal responses was addressed adequately. Combination of responses due to three directional seismic input motion was not addressed.

12. Do allowable design loads for concrete expansion anchors (Table 6-1 of "Reevaluation Criteria for Anchorage and Support of Safety Related Electrical Equipment") comply with the requirements of IE Bulletin No. 79-02.

13. Provide basis for elliptical interaction formula provided in Paragraph 6.2.6 for concrete expansion anchors.

REFERENCES

1. "Balance of Plant Mechanical Equipment and Piping Seismic Reevaluation Program, San Onofre Nuclear Generating Station, Unit 1," April, 1982.

2. "San Onofre Nuclear Generating Station, Unit 1, Reevaluation Criteria for Anchorage and Support of Safety Related Electrical Equipment," May 1, 1982.

COMMENTS ON SAN ONOFRE NUCLEAR GENERATING STATION UNIT 1 SEISMIC REEVALUATION AND MODIFICATION

Review of the "San Onofre Nuclear Generating Station Unit 1, Seismic Reevaluation and Modification," dated April 29, 1977 has been completed. Even though much of the general methodology seems adequate from an overall review standpoint, the details of applying the methods must be reviewed when individual analyses are available. The following comments are submitted. Although EG&G's responsibilities lie in the piping, mechanical, and electrical equipment areas, some comments overlap with the structural area. Those comments are included here since they may also affect subsequent subsystem and component analyses.

Page 3.7.2-10: How many degrees of freedom are at each node of the reduced reactor building and soil model? Apparently only 4 = 24/6 dofs are at each node possibly three translations and torsion? Is this sufficient?

Page 3.7.2-12: What technique was used to reduce the building model to a model with 24 degrees of freedom? Was Guyan Reduction (Static Condensation) or a more subjective method used?

Were mode shapes also compared between the reduced and full building models? Were time history responses also compared?

Page 3.7.2-14: Is the Chan-Cox-Benfield integration scheme an implicit or explicit scheme? Is artificial damping introduced with this method? Were equilibrium iterations or equilibrium checks performed? If so how frequently?

Page 3.7.2-17: In generating stiffness matrices for connected lines were the supports considered fixed at the concrete interfaces? If so how is the concrete motion at the support interface included? (Is inadvertent fixity introduced with these stiffness matrices?)

Was sloshing of the water in the pressurizer represented? If not why?

Page 3.7.2-24: Do the steam generator snubber stiffnesses include shell stiffness?

Do the seismic stop stiffnesses include shell stiffness?

Page 3.7.2-25,28: It is not obvious that activation of the negative spring at 0.20035 deflection will cancel all the other springs. Please clarify.

Page 3.7.2-31: Was any attempt made to model fluid/structural interaction, i.e., hydromass coupling between vessel and barrel, etc.? Why or why not?

Page 3.7.2-34: Is the mass lumping consistent with the static deflation used for the reduced reactor building model?

Page 3.7.2-42: When linearizing the NSSS system, what was the basis for selecting case (3) mixed gaps to analyze?

Page 3.7.2-43,44: It is questionable whether the test data can isolate barrel frequencies. Please justify how this was done.

Page 3.7.2-64,65: To determine the damping matrix for the nonlinear analyses what stiffness matrix is used (gaps open, closed, mixed, etc.)?

Is the damping matrix nonlinear? If linear, what is the justification for the particular [K] used in $[c] = \alpha[K] + \beta[m]$. Depending on the [K] chosen, significantly different damping coefficients in [c] may result.

Page 3.7.2-66: Is Rayleigh damping used in the RCS system model also? See above questions.

Page 3.7.3-6: What type of fluid element is used in the pump model, e.g., hydromass coupling?

Page 3.7.3-10: Is sloshing represented in the model of the pressurizer? Why or why not?

Page 3.7.3-20: Were both in-grid and thru-grid fuel response represented? Were thru-grid and in-grid allowables used?

Page 3.8.3-4 to 3.8.3-16: Clarify how the NSSS system model was reanalyzed with the RCS support modifications included. If it was not reanalyzed, justify why it was not necessary to do so.

Page 3.9.1-1: How has the WECAN computer code been verified? Licensee response in their April 12, 1982 letter addressing this question from previous review is unacceptable since the Westinghouse document WCAP-8281 has not been approved by NRC.

Page 3.9.1-7: Justify allowables used for components and component supports. Do they avoid large deformations?

Explain in more detail how a dynamic elastic analysis with geometric nonlinearities was performed?

Page 3.9.1-13,14: Is there any experimental justification for ratioing the grid buckling loads by the ratio of the wall (thickness) section moment of inertia? Does the grid buckle elastically or plastically?

Page 3.9.1-22: Section 3.9.1.5.5 is very poorly written and extremely confusing. In performing the component pump analysis with the detailed pump model, why wasn't the pump time history associated with the RCS modified supports model used for all stress calculations in the pump? Explain in more detail, the basis for choosing and using the 10.0 factor in the pump analysis.

Page 3.9.1-24: How were stresses in the steam generator increased in the time history analysis based on the response spectra comparision between the modified and unmodified RCS?

Were anchor movements incorporated in the support analysis?

Because the margin of safety is only 1.1 for many components, additional justification for use of the particular synthetic time history used in the non-linear analysis is required. Preferably, additional statistically independent time histories should be used to verify that the small safety margins are indeed conservative. Licensee response to this comment has previously been provided in their letter of April 12, 1982 but the justification provided is not acceptable.

REFERENCES

1. "San Onofre Nuclear Generating Station, Unit 1, NRC Docket 50-206, Seismic Reevaluation and Modification," April 29, 1977.

2. Enclosure to Southern California Edison Letter dated April 12, 1982.

APPENDIX B. ANALYSIS REVIEW GUIDELINES

The following is a list of guidelines to be used in reviewing analyses for the SEP Group II Plants. Although the list may not be all inclusive, it does provide the areas of interest pertaining to the SEP review.

I. Analysis Audit Format (Piping)

1. What computer codes were used in the analyses?

   a. How were the above computer codes verified?

2. Is the proper input forcing function being utilized?

   a. If response spectra method is used:

      (1) Is correct spectra and damping utilized?

      (2) Have sufficient modes been used to adequately describe system response?

      (3) Is spectra properly broadened?

      (4) Do system frequencies straddle any peaks?

   b. If time history method is used:

      (1) Is sufficient system response achieved?

      (2) Is an adequate time step utilized?

      (3) Is proper damping utilized?

c. If static equivalent method is used:

(1) Is justification provided for performing a static equivalent analysis?

(2) How was required level of input determined?

3. Has the piping system been properly modeled?

a. Have valves been properly modeled including any eccentricity?

b. Has adequate mass point spacing been utilized?

c. Are adjacent element length ratios reasonable?

d. Have all significant branch piping systems been included?

e. Have all supports been specified with correct imposed loads (if any), direction and stiffness?

f. Have supports with significant nonlinear characteristics been properly handled?

g. Have correct pipe sizes, geometry, thicknesses, and uniform weights been specified?

h. Have correct design and operating pressure and temperature data been specified?

4. Has the piping system been evaluated against proper criteria?

a. Has a proper minimum thickness check been performed?

b. Have excessive deflections been considered?

c. Have proper stress intensification factors been utilized?

d. Have proper load combinations been analyzed?

e. Have proper allowable stress limits been selected in order to assure the required operation of the piping?

f. Were standard or nonstandard components used?

g. What criteria were used in evaluating adequacy of supports?

II. Analysis Audit Format (Mechanical Equipment)

1. Is the equipment rigid or flexible?

a. How were the natural frequencies determined?

b. If flexible, is its response single-directional or multi-directional?

c. If flexible, is its response at one predominant frequency or at several frequencies?

2. What type of analysis was performed?

a. Static g level

(1) How was required level of input determined?

b. If response spectra method is used:

(1) Is correct spectra and damping utilized?

(2) Is sufficient system response achieved?

(3) Is spectra properly broadened?

(4) Do system frequencies straddle any peaks?

(5) How were directional components of input applied (combined)?

c. If time history method is used:

(1) Is sufficient system response achieved?

(2) Is an adequate time step utilized?

(3) Is proper damping utilized?

(4) How were directional components of input applied (combined)?

d. If testing was used for requalification:

(1) What type of test was performed?

(2) What justification is provided for the type of test used?

(3) How were system natural frequencies determined?

(4) How was the required response spectra (RRS) determined?

(5) How does the test response spectra (TRS) compare to the RRS?

(6) What g level was used in the test?

(7) Were support and boundary conditions, including anchor bolts, properly simulated in the test?

(8) How was functional operability verified during the test?

(9) What criteria were used in evaluating the adequacy of the test results?

3. What computer codes were used in the analyses?

   a. How were the above computer codes verified?

4. Has the system been properly modeled?

   a. Has adequate mass point spacing and distribution been used?

   b. Have all supports and boundary conditions, including anchor bolts, been properly modeled?

   c. Have significant nonlinear effects been properly handled?

5. Has the system been evaluated against proper criteria?

   a. Have the proper load combinations been analyzed?

   b. Have proper stress intensities been evaluated?

   c. Have deflections been considered?

   d. Have proper allowable stress limits been selected?

   e. How were computer output responses combined (directional and modal)?

III. Analysis Audit Format (Electrical Equipment)

1. Is the equipment rigid or flexible?

   a. How were the natural frequencies determined?

   b. If flexible, is its response single-directional or multi-directional?

   c. If flexible, is its response at one predominant frequency or at several frequencies?

2. What type of analysis was performed?

   a. Static g level

      (1) How was required level of input determined?

   b. If response spectra method is used:

      (1) Is correct spectra and damping utilized?

      (2) Is sufficient system response achieved?

      (3) Is spectra properly broadened?

      (4) Do system frequencies straddle any peaks?

      (5) How were directional components of input applied (combined)?

   c. If time history method is used:

      (1) Is sufficient system response achieved?

(2) Is an adequate time step utilized?

(3) Is proper damping utilized?

(4) How were directional components of input applied (combined)?

d. If testing was used for requalification:

(1) What type of test was performed?

(2) What justification is provided for the type of test used?

(3) How were system natural frequencies determined?

(4) How was the required response spectra (RRS) determined?

(5) How does the test response spectra (TRS) compare to the RRS?

(6) What g level was used in the test?

(7) Were support and boundary conditions, including anchor bolts, properly simulated in the test?

(8) How was functional operability verified during the test?

(9) What criteria were used in evaluating the adequacy of the test results?

3. What computer codes were used in the analyses?

a. How were the above computer codes verified?

4. Has the system been properly modeled?

   a. Has adequate mass point spacing and distribution been used?

   b. Have all supports and boundary conditions, including anchor bolts, been properly modeled?

   c. Have significant nonlinear effects been properly handled?

5. Has the system been evaluated against proper criteria?

   a. Have the proper load combinations been analyzed?

   b. Have proper stress intensities been evaluated?

   c. Have deflections been considered?

   d. Have proper allowable stress limits been selected?

   e. How were computer output responses combined (directional and modal)?